A New Possible Model to Issue Digital Currency

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Abstract. In this paper we consider a decentralized digital currency model to promote the development of global economic globalization. A new digital currency system derived by combining the characteristics of today's currency issuing system and digital currency. The different factors affecting the price of bitcoin through VAR model is given. Then we analyze the impact of digital currency on the current monetary system. The Inventory model for currency requirements presented to analyze the demand for cash transactions after the digital currency is used.

Keywords: digital currency; money supply; VAR model; Inventory model for currency requirements.

1. Introduction

The development of the Internet and other communication systems has accelerated the process of electronic currencyization and virtualization, which has led to changes in market entry methods, market transactions and payment methods [1-3]. As an emerging product, Bitcoin is a revolution in the history of money, and it has also triggered the thinking about digital currency. We have good reasons to study the viability and effects of a global decentralized digital financial market [4,5].

This paper presents a new possible model to issue digital currency. The paper is organized as follows. In Sect.2, VAR Model is given, In Sect.3, a model is constructed that adequately represents a global decentralized digital financial market, being sure to identify key factors that would limit or facilitate its growth, access, security, and stability at both the individual, national, and global levels., In Sec.4, The impact of digital currencies on the existing financial system is addressed.

2. Currency Issue Model

2.1 VAR Model of Bitcoin Price Factor

2.1.1 Introduction to the VAR Model

VAR (Vector autoregressive model) is a commonly used econometric model[6].

VAR adopts the simultaneous form of multiple equations. In each equation of the model, endogenous variables regression the lagged values of all endogenous variables of the model, so as to estimate the dynamic relationship of all endogenous variables[7]. VAR is often used to predict interconnected time series systems and to analyze the dynamic impact of random disturbances on variable systems, so as to explain the impact of various economic shocks on the formation of economic variables[8]. The analysis of a VAR model is usually to observe the impulse response function and variance decomposition of the system[9].

2.1.2 VAR Model Stability Test

The vector autoregressive model is a non-structural equation model for the study of the relationship between individual variables in the case of time series [10]. Considering that bitcoin as a virtual currency has the characteristics of high profit and high risk, traditional investment instruments such as stock price, gold price, and commodity price index will have some influence on bitcoin price fluctuation to some extent. Therefore, the variables selected in this paper are bitcoin dollar price, gold price, stock price index, CRB (Commodity Research Bureau), and four variables are named: price, gold, stock and commodity. In the actual analysis process, in order to rationalize the differences between different variables, eliminate the heteroscedasticity that may exist between the variables, and logarithmically transform of the data. At the same time, in order to avoid the pseudo-regression

problem, the ADF stationarity test is performed on the new variable and its first-order difference. The results show that the bitcoin price, gold price, stock price index and logarithmic first-order difference sequence of CRB are all stationary time series. Therefore, based on the AIC and SC rules, establish a VAR model with a lag period of 1, which is VAR (1).
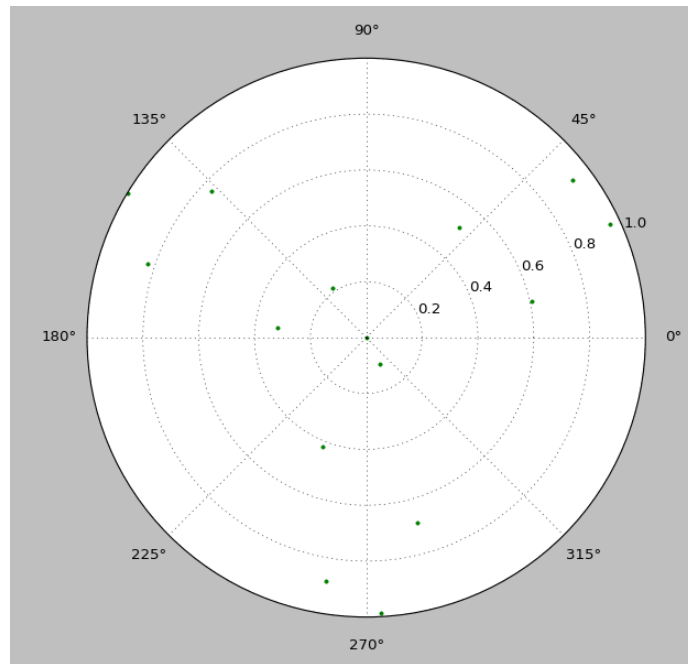

Figure 1. Inverse roots of AR characteristic polynomial

It can be seen from Fig. 1 that the reciprocal of the root of the AR characteristic polynomial is in the unit circle, indicating that the estimated VAR model is stable.

2.1.3 Johansen Cointegration Test

The cointegration relationship tests the stationarity of long-term linear combinations of non-stationary time series satisfying the same order, and explores the long-term equilibrium relationship between time series.

Assuming the sequence of independent variables is $\{x_1\},...\{x_k\}$, the sequence of response variables is $\{y_t\}$, construct a regression model

$$y_t = \beta_0 + \sum_{i=1}^{k} \beta_i x_i + \varepsilon_t \tag{1}$$

To test the co-integration relationship between the response variables $\{y_t\}$ and the independent variables sequence $\{x_1\},...,\{x_k\}$.

Table 1. Granger causality test was conducted on the variables

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistics	0.05 Critical Value	Prob.
None	0.228458	30.34897	40.17493	0.3365
At most 1	0.059829	8.043711	24.27596	0.9496
At most 2	0.031151	2.738057	12.3209	0.8792
At most 3	0.000192	0.016494	4.129906	0.9164

As can be seen from table 1, there is no co-integration relationship between the four variables, that is, there is no long-term equilibrium relationship. Based on this, Granger causality test was conducted

on the variables to explore whether there is a causal relationship of short-term lag between these variables.

2.1.4 Granger Causality Test

Table 2. Granger causality test

Dependent variable	Excluded	Chi-sq	Pro.
Lngold	Lnprice	0.418598	0.8112
	Lncommodity	8.447617	0.0146
	Lnstock	8.393906	0.015
	All	17.77302	0.0068
Lnprice	Lnstock	0.99014	0.6095
	Lncommodity	2.787907	0.2481
	Lngold	0.68725	0.7092
	All	3.318246	0.768
Lnstock	Lngold	3.121371	0.21
	Lnprice	12.56398	0.0019
	Lncommodity	11.20307	0.0037
	All	25.02787	0.0003
Lncommodity	Lngold	1.830521	0.4004
	Lnprice	0.120928	0.9413
	Lnstock	3.154888	0.2065
	All	5.289584	0.5072

The causality test results of the VAR model give the Granger causality test results of the equation corresponding to each endogenous variable relative to the remaining variables in the model. As can be seen from table 2, bitcoin price and stock index are the cause of commodity price, and there is Granger causality between them. All test results are given in the lag variable joint significant test χ^2 statistics, it can be seen that the endogenous variable gold prices, commodity prices relative to the other three variables lag is joint significantly.

2.1.5 Variance Decomposition

Variance decomposition method was used to analyze the contribution of three variables to bitcoin price changes.

Table 3. Variance decomposition

Period	S.E.	LNGOLD	LNPRICE	LNSTOCK	LNCOMMODITY
1	0.016499	0.726089	97.80602	1.087476	0.380412
2	0.017953	0.710416	97.81376	1.022271	0.453556
3	0.019223	0.71098	97.76794	0.982828	0.538253
4	0.020334	0.72462	97.65861	0.967429	0.649343
5	0.021303	0.749705	97.493	0.974129	0.78317
6	0.022148	0.784765	97.27295	0.999595	0.942689
7	0.022884	0.828638	97.00447	1.040502	1.12639
8	0.023522	0.880155	96.69302	1.093436	1.333392
9	0.024074	0.938177	96.34521	1.155255	1.561359
10	0.024552	1.001551	95.96765	1.223115	1.80768

It can be seen from table 3 that the predicted standard deviation of bitcoin price is small, the predicted result is good, and increases with the increase of the forecast period.

On the one hand, the prediction in period i includes the influence of the uncertainty factors in the previous phase, and the standard deviation of the prediction also increases slowly over time. The part of the variance of the price prediction caused by the disturbance of non-price variables, namely gold price, stock price and commodity price, generally shows an upward trend of fluctuation

2.2 Digital Currency Circulation Model

2.2.1 Initial Circulation

Assuming that the average daily circulation of a global currency is equivalent to B in us dollars, the first-day circulation of the digital currency is set at B.

2.2.2 Daily Circulation

The circulation of digital currency is based on B, and the three factors of gold price, stock index and CRB affect the daily circulation. Different proportions of variance decomposition are used to determine their different weights in the circulation of digital currency and the final daily circulation

$$amount = 0.7B + (\lambda_1 * \frac{gold}{gold_0} + \lambda_2 \frac{stock}{stock_0} + \lambda_3 \frac{commodity}{commodity_0}) * 0.3B \tag{2}$$

Here the λ_1, λ_2, λ_3 are the coefficients of three factors. $gold_0$, $stock_0$, $commodity_0$ are the corresponding indexes of each factor on the first day of issuance.

We choose the proportion of different factors in the first period of variance decomposition to determine the value of λ:

$$\lambda_1 = \frac{\ln gold}{100 - \ln price} \tag{3}$$

$$\lambda_2 = \frac{\ln stock}{100 - \ln price} \tag{4}$$

$$\lambda_3 = \frac{commodity}{100 - \ln price} \tag{5}$$

3. The Impact of Digital Currencies on the Existing Financial System

3.1 The Impact of Digital Currencies on Demand for Transactional Currencies

3.1.1 Model Establishment

With the development of digital currency, cash in circulation will become less and less important. Figure 2 shows the trend of China's currency deposit ratio in 1999-2017. The currency deposit ratio reflects the degree of preference of the economic participants to cash to a certain extent. Mobile payment is very popular in China. The scale of mobile payment in China is about 50 times that of the United States. By referring to the trend of China's currency deposit ratio, it is easy to get the conclusion that cash demand will be less and less.
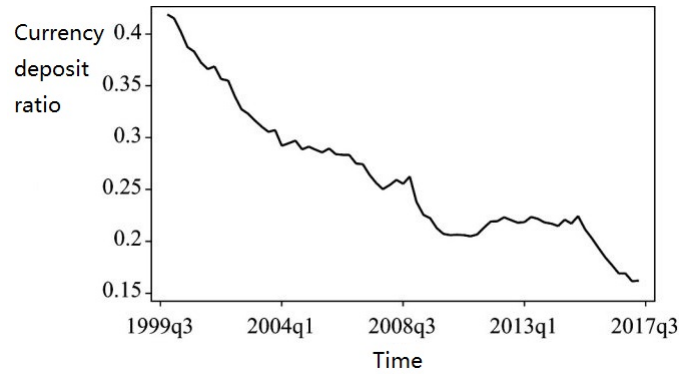
Figure 2. China's currency deposit ratio changes

Baumol and tobin respectively put forward the decisive theory on the demand for transactional money (Baumol, 1952[8]; Tobin, 1956[9]). Called the inventory model of money demand, the square root formula of this model is

$$M_d = \sqrt{YF/(2r)} \qquad (6)$$

Which M_d is transactions demand for money,Y is the total transaction amount (revenue), F is the realization cost of each transaction, and r is the interest rate (measuring the opportunity cost of holding currency) [11][12], Thus, it is proved that there is a certain relationship between transaction demand and interest rate and income[13], that is, the more the realization cost F is, or the more the expenditure Y is, or the lower the interest rate r is, the more money the individual holds.
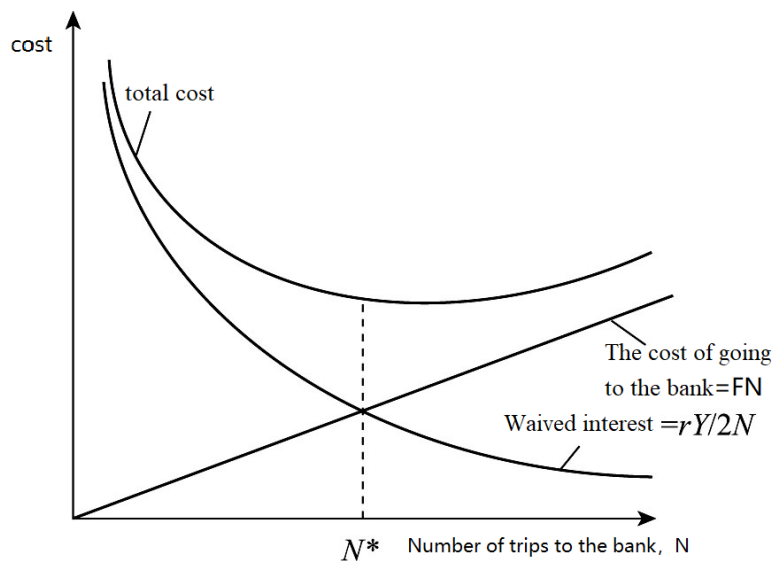

Figure 3. The cost of holding currency

Figure 3 shows how the total cost depends on the number of times N you go to the bank.Waived interest (rY /2N) ,The cost of going to the bank(F·N) and the total cost (rY /2N + F·N) depends on how many times you go to the bank. There is an N that minimizes the total cost, which is the N marked in figure 2 $N*$,

$$N* = \sqrt{rY/(2F)} \qquad (7)$$

The corresponding solution is that the average money holdings are

$$M_d = \sqrt{YF/(2r)} \qquad (8)$$

Assuming that an individual is either fully in cash or fully in digital currency, the bond pays an interest rate of r_b, the digital currency has an interest rate of r_e ($r_e<r_b$), and cash does not bring any interest, undertake detailed analysis below.

3.1.2 Individuals Hold All Cash for Transactions

We interpret the baumol-tobin model as the demand for money model, which we use to explain the amount of money held outside the bank [14]. In fact, we can interpret this model more broadly. Imagine an individual holding a portfolio of monetary assets (cash or digital currency) and non-monetary assets (bonds). Currency assets can be traded but only digital currencies have a yield. Let r in the previous baumol-tobin model represent the difference between the income of monetary assets and that of non-monetary assets, and F represents the cost of converting non-monetary assets into monetary assets, such as handling fee (called conversion cost). Therefore, Baumol Tobin model describes the individual's demand for monetary assets. According to the previous baumol-tobin model, the total cost that individuals bear for transaction payment is the sum of the abandoned interest and conversion cost:

$$\text{Total cost} = \text{forgone interest} + \text{conversion cost}$$

The total cost in the case that an individual holds all cash for transactions is recorded as Cm, the single conversion cost is recorded as Fm, the conversion frequency is recorded as Nm, and the expenditure is recorded as Y, there are

$$C_m = (r_b - 0)Y/(2N_m) + F_m * N_m \tag{9}$$

Therefore, the optimal conversion times N_m^* and M_m^* that minimize the cost can be obtained

$$N_m^* = \sqrt{(r_b Y)/(2F_m)} \tag{10}$$

$$M_m^* = Y/(2N_m^*) = \sqrt{YF_m/(2r_b)} \tag{11}$$

3.1.3 Individuals Hold Digital Currencies Entirely for Transactions

Similarly, according to the previous baumol-tobin model, the total cost that individuals bear for transaction payment is the sum of the abandoned interest and conversion cost:

$$\text{Total cost} = \text{forgone interest} + \text{conversion cost}$$

The total cost for an individual to fully hold a digital currency to trade is recorded as C_e, The cost of a single conversion is denoted as F_e, The number of transformations is denoted by N_e, Expenditure is denoted as Y, then there is

$$C_e = (r_b - r_e)Y/(2N_e) + F_e * N_e \tag{12}$$

According to this, the optimal conversion times N_e^* and the average currency holdings M_e^* that minimize the cost can also be obtained:

$$N_e^* = \sqrt{(r_b - r_e) * Y/(2F_e)} \tag{13}$$

$$M_m^* = Y/(2N_m^*) = \sqrt{YF_m/(2r_b)} \tag{14}$$

Whether converting from bonds to cash or from bonds to digital currency, assume that the handling fee (conversion cost) for each conversion is the same F, namely $F_m = F_e = F$,

Then, the average monetary asset holdings M_m^* when an individual holds all cash for transactions and M_e^* when an individual holds all digital currency for transactions are:

$$M_m^* = \sqrt{YF/(2r_b)} \tag{15}$$

$$M_e^* = \sqrt{YF/2(r_b - r_e)} \tag{16}$$

By comparing the money asset holdings in these two cases, it can be found that the demand for transaction currency of holding cash and digital currency is negatively correlated with the bond interest rate rb, and positively correlated with the fixed cost F of each conversion (if the cost does not depend on the number of bonds included in the conversion).

3.2 Impact on International Currency Exchange

Money is now issued on a national basis, with the exception of the European Union[15]. In this way, an issuing unit forms an economy, which has many advantages, but also has certain disadvantages. In the monetary system described above, in the digital currency era, international exchange will adopt the rule that money does not go out. That is to say, digital currency only operates in its ledger, no longer flows in and out, but worldwide commodities can. The main reason for adopting this principle is to ensure the balance between import and export and to maintain the general equality between production and harvest. In order to be able to do this and facilitate the worldwide flow of goods, national accounts will be established to facilitate cross-border transactions through the interaction of individual and national accounts as well as between national accounts. It can complete the exchange between digital currency countries and paper currency countries as well as the exchange between digital currency and digital currency countries. With the development of science and technology, the integration of world currency is just a matter of time.

Acknowledgements

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